To be consistent with the requirements of the Act, the State's procedure to be applied to the narrative criterion must be submitted to EPA for review and approval, and will become a part of the State's water quality standards. (See 40 CFR 131.21 for further discussion.) This requirement may be satisfied by a reference in the standards to the procedure, which may be contained in another document, which has legal effect and is binding on the State, and all the requirements for public review, State implementation, and EPA review and approval are satisfied.

Criteria Based on Biological Monitoring

For priority toxic pollutants for which EPA has not issued section 304(a)(1) criteria guidance, CWA section 303(c)(2)(B) requires States to adopt criteria based on biological monitoring or assessment methods. The phrase "biological monitoring or assessment methods" includes:

- whole-effluent toxicity control methods;
- biological criteria methods; or
- other methods based on biological monitoring or assessment.

The phrase "biological monitoring or assessment methods" in its broadest sense also includes criteria developed through translator procedures. This broad interpretation of that phrase is consistent with EPA's policy of applying chemical-specific, biological, and whole-effluent toxicity methods independently in an integrated toxics control program. It is also consistent with the intent of Congress to expand State standards programs beyond chemical-specific approaches.

States should also consider developing protocols to derive and adopt numeric criteria for priority toxic pollutants; (or other pollutants) where EPA has not issued section 304(a) criteria guidance. The S (ate should consider available laboratory toxicity test data that may be sufficient to support derivation of chemical-specific criteria. Existing data need not be as comprehensive as that required to meet EPA's 1985 guidelines in order for a State to use its own protocols to derive criteria. EPA has described such protocols in the proposed *Water Quality Guidance for the Great Lakes System (58 F.R. 20892, at 21016, April 16, 1993) (PDF)* (167 pp, 318K). This is particularly important where other components of a State's narrative criterion implementation procedure (*e.g.*, WET controls or biological criteria) may not ensure full protection of designated uses. For some pollutants, a combination of chemical-specific and other approaches is necessary (*e.g.*, pollutants where bioaccumulation in fish tissue or water consumption by humans is a primary concern).

Biologically based monitoring or assessment methods serve as the basis for control where no specific numeric criteria exist or where calculation or application of pollutant-by-pollutant criteria appears infeasible. Also, these methods may serve as a supplemental measurement of attainment of water quality standards in addition to numeric and narrative criteria. The requirement for both numeric criteria and biologically based methods demonstrates that section 303(c)(2)(B) contemplates that States develop a comprehensive toxics control program regardless of the status of EPA's section 304(a) criteria.

The whole-effluent toxicity (WET) testing procedure is the principal biological monitoring guidance developed by EPA to date. The purpose of the WET procedure is to control point source dischargers of toxic pollutants. The procedure is particularly useful for monitoring and controlling the toxicity of complex effluents that may not be well controlled through chemical-specific numeric criteria. As such, biologically based effluent testing procedures are a necessary component of a State's toxics control program under section 303(c)(2)(B) and a principal means for implementing a State's narrative "free from toxics" standard.

Guidance documents EPA considers to serve the purpose of section 304(a)(8) include the *Technical Support Document for Water Quality-based Toxics Control (USEPA, 1991a) (PDF)* (335 pp, 26.6MB); *Guidelines for Deriving National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses (PDF)* (59 pp, 557K); *Guidelines and Methodology Used in the Preparation of Health Effect Assessment Chapters of the Consent Decree Water Criteria Documents; Methods for Measuring Acute Toxicity of Effluents to Freshwater and Marine Organisms (USEPA, 1991d); Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms (USEPA, 2002)*; and *Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Marine and Estuarine Organisms (USEPA, 2002)*.

—3.4.2 Criteria for Nonconventional Pollutants

Criteria requirements applicable to toxicants that are not priority toxic pollutants (e.g., ammonia and chlorine), are specified in the Water Quality Standards Regulation (see 40 CFR 131.11). Under these requirements, States must adopt criteria based on sound scientific rationale that cover sufficient parameters to protect designated uses. Both numeric and narrative criteria (discussed in sections 3.5.1 and 3.5.2, below) may be applied to meet these requirements.

3.5 Forms of Criteria

States are required to adopt water quality criteria, based on sound scientific rationale, that contain sufficient parameters or constituents to protect the designated use. EPA believes that an effective State water quality standards program should include both parameter-specific (e.g., ambient numeric criteria) and narrative approaches.

Updated Information

- Water Quality Criteria for Nitrogen and Phosphorus Pollution - This website provides basic information about nitrogen and phosphorus pollution and the development of numeric nutrient criteria. Links to status of state criteria development.
- Technical Support for Numeric Nutrient Criteria Development – This website provides technical resources to aid in the development of numeric nitrogen and phosphorus criteria per the goals of EPA's comprehensive framework issued in 2011.

—3.5.1 Numeric Criteria

Numeric criteria are required where necessary to protect designated uses. Numeric criteria to protect aquatic life should be developed to address both short-term (acute) and long-term (chronic) effects. Saltwater species, as well as freshwater species, must be adequately protected. Adoption of numeric criteria is particularly important for toxicants known to be impairing surface waters and for toxicants with potential human health impacts (e.g., those with high bioaccumulation potential). Human health should be protected from exposure resulting from consumption of water and fish or other aquatic life (e.g., mussels, crayfish). Numeric water quality criteria also are useful in addressing nonpoint source pollution problems.

In evaluating whether chemical-specific numeric criteria for toxicants that are not priority toxic pollutants are required, States should consider whether other approaches (such as whole-effluent toxicity criteria or biological controls) will ensure full protection of designated uses. As mentioned above, a combination of independent approaches may be required in some cases to support the designated uses and comply with the requirements of the Water Quality Standards Regulation (e.g., pollutants where bioaccumulation in fish tissue or water consumption by humans is a primary concern).

—3.5.2 Narrative Criteria

To supplement numeric criteria for toxicants, all States have also adopted narrative criteria for toxicants. Such narrative criteria are statements that describe the desired u'water quality goal, such as the following:

All waters, including those within mixing zones, shall be free from substances attributable to wastewater discharges or other pollutant sources that:

1. Settle to form objectional deposits;
2. Float as debris, scum, oil, or other matter forming nuisances;
3. Produce objectionable color, odor, taste, or turbidity;
4. Cause injury to, or are toxic to, or produce adverse physiological responses in humans, animals, or plants; or
5. Produce undesirable or nuisance aquatic life (54 F.R. 28627, July 6, 1989).

EPA considers that the narrative criteria apply to all designated uses at all flows and are necessary to meet the statutory requirements of section 303(c)(2)(A) of the CWA.

Narrative toxic criteria (No. 4, above) can be the basis for establishing chemical-specific limits for waste discharges where a specific pollutant can be identified as causing or contributing to the toxicity and the State has not adopted chemical-specific numeric criteria. Narrative toxic criteria are cited as a basis for establishing whole-effluent toxicity controls in EPA permitting regulations at 40 CFR 122.44(d)(l)(v).

To ensure that narrative criteria for toxicants are attained, the Water Quality Standards Regulation requires States to develop implementation procedures (see 40 CFR 131.11 (a)(2)). Such implementation procedures (Exhibit 3-3) should address all mechanisms to be used by the State to ensure that narrative criteria are attained. Because implementation of chemical-specific numeric criteria is a key component of State toxics control programs, narrative criteria implementation procedures must describe or reference the State's procedures to implement such chemical-specific numeric criteria (e.g., procedures for establishing chemical-specific permit limits under the NPDES permitting program). Implementation procedures must also address State programs to control whole-effluent toxicity (WET) and may address programs to implement biological criteria, where such programs have been developed by the State. Implementation procedures therefore serve as umbrella documents that describe how the State's various toxics control programs are integrated to ensure adequate protection for aquatic life and human health and attainment of the narrative toxics criterion. In essence, the procedure should apply the "independent application" principle, which provides for independent evaluations of attainment of a designated use based on chemical- specific, whole-effluent toxicity, and biological criteria methods (see section 3.5.3 and Appendices C, K, and R).

EPA encourages, and may ultimately require, State implementation procedures to provide for implementation of biological criteria. However, the regulatory basis for requiring whole-effluent toxicity (WET) controls is clear. EPA regulations at 40 CFR 122.44(d)(l)(v) require NPDES permits to contain WET limits where a permittee has been shown to cause, have the reasonable potential to cause, or contribute to an in-stream excursion of a narrative criterion. Implementation of chemical-specific controls is also required by EPA regulations at 40 CFR 122.44(d)(l). State implementation procedures should, at a minimum, specify or reference methods to be used in implementing chemical-specific and whole-effluent toxicity-based controls, explain how these methods are integrated, and specify needed application criteria.

In addition to EPA's regulation at 40 CFR 131, EPA has regulations at 40 CFR 122.44 that cover the National Surface Water Toxics Control Program. These regulations are intrinsically linked to the requirements to achieve water quality standards, and specifically address the control of pollutants both with and without numeric criteria. For example, section 12?.44(d)(l)(vi) provides the permitting authority with several options for establishing effluent limits when a State does not have a chemical-specific numeric criterion for a pollutant present in an effluent at a concentration that causes or contributes to a violation of the State's narrative criteria.

Exhibit 3-3. Components of a State Implementation Procedure for Narrative Toxics Criteria

State implementation procedures for narrative toxics criteria should describe the following:

- Specific, scientifically defensible methods by which the State will implement its narrative toxics standard for all toxicants, including:
  - methods for chemical-specific criteria, including methods for applying chemical-specific criteria in permits, developing or modifying chemical-specific criteria via a "translator procedure" (defined and discussed below), and calculating site-specific criteria based on local water chemistry or biology);
  - methods for developing and implementing whole-effluent toxicity criteria and/or controls; and
  - methods for developing and implementing biological criteria.
- How these methods will be integrated in the State's toxics control program (i.e., how the State will proceed when the specified methods produce conflicting or inconsistent results).
- Application criteria and information needed to apply numerical criteria, for example:
  - methods the State will use to identify those pollutants to be regulated in a specific discharge;
  - an incremental cancer risk level for carcinogens;
  - methods for identifying compliance thresholds in permits where calculated limits are below detection;
  - methods for selecting appropriate hardness, pH, and temperature variables for criteria expressed as functions;
  - methods or policies controlling the size and in-zone quality of mixing zones;
  - design flows to be used in translating chemical-specific numeric criteria for aquatic life and human health into permit limits; and
  - other methods and information needed to apply standards on a case-by-case basis.

—3.5.3 Biological Criteria

The Clean Water Act of 1972 directs EPA to develop programs that will evaluate, restore, and maintain the chemical, physical, and biological integrity of the Nation's waters. In response to this directive, States and EPA have implemented chemically based water quality programs that address significant water pollution problems. However, over the past 20 years, it has become apparent that these programs alone cannot identify and address all surface water pollution problems. To help create a more comprehensive program, EPA is setting a priority for the development of biological criteria as part of State water quality standards. This effort will help States and EPA (1) achieve the biological integrity objective of the CWA set forth in section 101, and (2) comply with the statutory requirements under sections 303 and 304 of the Act (see Appendices C and K).

Updated Information

- Biocriteria - Bioassessment and Biocriteria – This website provides basic information on biocriteria and links to bioassessment and biocriteria program technical guidance for streams and small rivers, lakes, estuaries, wetlands, and coral reefs.

Regulatory Bases for Biocriteria

The primary statutory basis for EPA's policy that States should develop biocriteria is found in sections 101(a) and 303(c)(2)(B) of the Clean Water Act. Section 101(a) of the CWA gives the general goal of biological criteria. It establishes as the objective of the Act the restoration and maintenance of the chemical, physical, and biological integrity of the Nation's waters. To meet this objective, water quality criteria should address biological integrity. Section 101(a) includes the interim water quality goal for the protection and propagation of fish, shellfish, and wildlife.

Section 304(a) of the Act provides the legal basis for the development of informational criteria, including biological criteria. Specific directives for the development of regulatory biocriteria can be found in section 303(c), which requires EPA to develop criteria based on biological assessment methods when numerical criteria are not established.

- Biocriteria: Technical Assistance and Guidance Documents – This website provides links to general biocriteria technical guidance and policy documents published by the EPA, USGS, and others.
- Primer on Using Biological Assessments to Support Water Quality Management (2011) (PDF) (108 pp, 6.13MB) - See page 31 for an example of developing biological criteria in Arizona.

- the effects of pollutants on aquatic community components ("...plankton, fish, shellfish, wildlife, plant life ...") and community attributes ("...biological community diversity, productivity, and stability ...") in any body of water; and
- factors necessary " ...to restore and maintain the chemical, physical, and biological integrity of all navigable waters ..." for " ...the protection of shellfish, fish, and wildlife for classes and categories of receiving waters , ..."

Once biocriteria are formally adopted into State standards, biocriteria and aquatic life use designations serve as direct, legal endpoints for determining aquatic life use attainment/non- attainment. CWA section 303(c)(2)(B) provides that when numeric criteria are not available, States shall adopt criteria for toxics based on biological monitoring or assessment methods; biocriteria can be used to meet this requirement.

Development and Implementation of Biocriteria

Biocriteria are numerical values or narrative expressions that describe the expected reference biological integrity of aquatic communities inhabiting waters of a designated aquatic life use. In the most desirable scenario, these would be waters that are either in pristine condition or minimally impaired. However, in some areas these conditions no longer exist and may not be attainable. In these situations, the reference biological communities represent the best attainable conditions. In either case, the reference conditions then become the basis for developing biocriteria for major surface water types (streams, rivers, lakes. wetlands, estuaries, or marine waters).

Biological criteria support designated aquatic life use classifications for application in State standards (see chapter 2). Each State develops its own designated use classification system based on the generic uses cited in the Act (e.g., protection and propagation of fish, shellfish, and wildlife). Designated uses are intentionally general. However, States may develop subcategories within use designations to refine and clarify the use class. Clarification of the use class is particularly helpful when a variety of surface waters with distinct characteristics fit within the same use class, or do not fit well into any category.

For example, subcategories of aquatic life uses may be on the basis of attainable habitat (e.g., coldwater versus warmwater stream systems as represented by distinctive trout or bass fish communities, respectively). Special uses may also be designated to protect particularly unique, sensitive, or valuable aquatic species, communities, or habitats.

Resident biota integrate multiple impacts over time and can detect impairment from known and unknown causes. Biological criteria can be used to verify improvement in water quality in response to regulatory and other improvement efforts and to detect new or continuing degradation of waters. Biological criteria also provide a framework for developing improved best management practices and management measures for nonpoint source impacts. Numeric biological criteria can provide effective monitoring criteria for more definitive evaluation of the health of an aquatic ecosystem.

The assessment of the biological integrity of a water body should include measures of the structure and function of the aquatic community within a specified habitat. Expert knowledge of the system is required for the selection of appropriate biological components and measurement indices. The development and implementation of biological criteria requires:

- selection of surface waters to use in developing reference conditions for each designated use;
- measurement of the structure and function of aquatic communities in reference surface waters to establish biological criteria;
- measurement of the physical habitat and other environmental characteristics of the water resource; and
- establishment of a protocol to compare the biological criteria to biota in comparable test waters to determine whether impairment has occurred.

These elements serve as an interactive network that is particularly important during early development of biological criteria where rapid accumulation of information is effective for refining both designated uses and developing biological criteria values and the supporting biological monitoring and assessment techniques.

—3.5.4 Sediment Criteria

While ambient water quality criteria are playing an important role in assuring a healthy aquatic environment, they alone have not been sufficient to ensure appropriate levels of environmental protection. Sediment contamination, which can involve deposition of toxicants over long periods of time, is responsible for water quality impacts in some areas.

EPA has authority to pursue the development of sediment criteria in streams, lakes and other waters of the United States under sections 104 and 304(a)(1) and (2) of the CWA as follows:

Updated Information

- Contaminated Sediments in Water – This website provides basic information and links to technical guidance and policy documents on contaminated sediments.
- Suspended and Bedded Sediments (2003) – This website provides links to the draft guidance and appendices for developing water quality criteria for suspended and bedded sediments.

- section 104(n)(1) authorizes the Administrator to establish national programs that study the effects of pollution, including sedimentation, in estuaries on aquatic life;
- section 304(a)(1) directs the Administrator to develop and publish criteria for water quality, including information on the factors affecting rates of organic and inorganic sedimentation for varying types of receiving waters;
- section 304(a)(2) directs the Administrator to develop and publish information on, among other issues, "the factors necessary for the protection and propagation of shellfish, fish, and wildlife for classes and categories of receiving waters...."

To the extent that sediment criteria could be developed that address the concerns of the section 404(b)(1) Guidelines for discharges of dredged or fill material under the CWA or the Marine Protection, Research, and Sanctuaries Act, they could also be incorporated into those regulations.

EPA's current sediment criteria development effort, as described below, focuses on criteria for the protection of aquatic life. EPA anticipates potential future expansion of this effort to include sediment criteria for the protection of human health.

Chemical Approach to Sediment Criteria Development

Over the past several years, sediment criteria development activities have centered on evaluating and developing the Equilibrium Partitioning Approach for generating sediment criteria. The Equilibrium Partitioning Approach focuses on predicting the chemical interaction between sediments and contaminants. Developing an understanding of the principal factors that influence the sediment/contaminant interactions will allow predictions to be made regarding the level of contaminant concentration that benthic and other organisms may be exposed to. Chronic water quality criteria, or possibly other toxicological endpoints, can then be used to predict potential biological effects. In addition to the development of sediment criteria, EPA is also working to develop a standardized sediment toxicity test that could be used with or independently of sediment criteria to assess chronic effects in fresh and marine waters.

> Equilibrium Partitioning (EqP) Sediment Quality Criteria (SQC) are the U.S. Environmental Protection Agency's best recommendation of the concentration of a substance in sediment that will not unacceptably affect benthic organisms or their uses.

Methodologies for deriving effects-based SQC vary for different classes of compounds. For non-ionic organic chemicals, the methodology requires normalization to organic carbon. A methodology for deriving effects-based sediment criteria for metal contaminants is under development and is expected to require normalization to acid volatile sulfide. EqP SQC values can be derived for varying degrees of uncertainty and levels of protection, thus permitting use for ecosystem protection and remedial programs.

Application of Sediment Criteria

SQC would provide a basis for making more informed decisions on the environmental impacts of contaminated sediments. Existing sediment assessment methodologies are limited in their ability to identify chemicals of concern, responsible parties, degree of contamination, and zones of impact. To make the most informed decisions, EPA believes that a comprehensive approach using SQC and biological test methods is preferred.

Sediment criteria will be particularly valuable in site-monitoring applications where sediment contaminant concentrations are gradually approaching a criterion over time or as a preventive tool to ensure that point and nonpoint sources of contamination are controlled and that uncontaminated sediments remain uncontaminated.

Also comparison of field measurements to sediment criteria will be a reliable method for providing early warning of a potential problem. An early warning would provide an opportunity to take corrective action before adverse impacts occur. For the reasons mentioned above, it has been identified that SQC are essential to resolving key contaminated sediment and source control issues in the Great Lakes.

Specific Applications

Specific applications of sediment criteria are under development. The primary use of FqP-based sediment criteria will be to assess risks associated with contaminants in sediments. The various offices and programs concerned with contaminated sediment have different regulatory mandates and, thus, have different needs and areas for potential application of sediment criteria. Because each regulatory need is different, EqP- based sediment quality criteria designed specifically to meet the needs of one office or program may have to be implemented in different ways to meet the needs of another office or program.

One mode of application of FqP-based numerical sediment quality criteria would be in a tiered approach. In such an application, when contaminants in sediments exceed the sediment quality criteria the sediments would be considered as causing unacceptable impacts. Further testing may or may not be required depending on site-specific conditions and the degree in which a criterion has been violated. (In locations where contamination significantly exceeds a criterion, no additional testing would be required. Where sediment contaminant levels are close to a criterion, additional testing might be necessary.) Contaminants in a sediment at concentrations less than the sediment criterion would not be of concern. However, in some cases the sediment could not be considered safe because it might contain other contaminants above safe levels for which no sediment criteria exist. In addition, the synergistic, antagonistic, or additive effects of several contaminants in the sediments may be of concern.

Additional testing in other tiers of an evaluation approach, such as toxicity tests, could be required to determine if the sediment is safe. It is likely that such testing would incorporate site-specific considerations. Examples of specific applications of sediment criteria after they are developed include the following:

- Establish permit limits for point sources to ensure that uncontaminated sediments remain uncontaminated or sediments already contaminated have an opportunity to cleanse themselves. Of course, this would occur only after criteria and the means to tie point sources to sediment contamination are developed.
- Establish target levels for nonpoint sources of sediment contamination.
- For remediation activities, SQC would be valuable in identifying:
  - need for remediation,
  - spatial extent of remediation area,
  - benefits derived from remediation activities,
  - responsible parties,
  - impacts of depositing contaminated sediments in water environments, and
  - success of remediation activities.

Sediment Criteria Status

Science Advisory Board Review

The Science Advisory Board has completed a second review of the EqP approach to deriving sediment quality criteria for non-ionic contaminants. The November 1992 report (USEPA, 1992c) endorses the EqP approach to deriving criteria as "...sufficiently valid to be used in the regulatory process if the uncertainty associated with the method is considered, described, and incorporated," and that "EPA should ...establish criteria on the basis of present knowledge within the bounds of uncertainty...."

The Science Advisory Board also identified the need for "...a better understanding of the uncertainty around the assumptions inherent in the approach, including assumptions of equilibrium, bioavailability, and kinetics, all critical to the application of the EqP."

Sediment Criteria Documents and Application Guidance

EPA efforts at producing sediment criteria documents are being directed first toward phenanthrene, fluoranthene. dieldrin, acenaphthene, and endrin. Efforts are also being directed towards producing a guidance document on the derivation and interpretation of sediment quality criteria. The criteria documents were announced in the Federal Register in January 1994; the public comment period ended June 1994. Final documents and implementation guidance should be available in early 1996.

Methodology for Developing Sediment Criteria for Metal Contaminants

EPA is proceeding to develop a methodology for calculating sediment criteria for benthic toxicity to metal contaminants, with key work focused on identifying and understanding the role of acid volatile sulfides (AVS), and other binding factors, in controlling the bioavailability of metal contaminants. A variety of field and laboratory verification studies are under way 10 add additional support to the methodology. Standard AVS sampling and analytical procedures are under development. Presentation of the metals methodology to the SAB for review is anticipated for Fall 1994.

Biological Approach to Sediment Criteria Development

Under the Contaminated Sediment Management Strategy (PDF) (131 pp, 697K), EPA programs have committed to using consistent biological methods to determine if sediments are contaminated. In the water program, these biological methods will be used as a complement to the sediment-chemical criteria under development. The biological methods consist of both toxicity and bioaccumulation tests. Freshwater and saltwater benthic species, selected to represent the sensitive range of species' responses to toxicity. are used in toxicity tests to measure sediment toxicity. Insensitive freshwater and saltwater benthic species that form the base of the food chain are used in toxicity tests to measure the bioaccumulation potential of sediment. In FY 1994, acute toxicity tests and bioaccumulation tests selected by all the Agency programs should be standardized and available for use. Training for States and EPA Regions on these methods is expected to begin in FY 1995.

In the next few years, research will be conducted to develop standardized chronic toxicity tests for sediment as well as toxicity identification evaluation (TIE) methods. The TIE approach will be used to identify the specific chemicals in a sediment causing acute or chronic toxicity in the test organisms. Under the Contaminated Sediment Management Strategy, EPA's programs have also agreed to incorporate these chronic toxicity and TIE methods into their sediment testing when they are available.

—3.5.5 Wildlife Criteria

Terrestrial and avian species arc useful as sentinels for the health of the ecosystem as a whole. In many cases, damage to wildlife indicates that the ecosystem Itself is damaged. Many wildlife species that are heavily dependent on the aquatic food web reflect the health of aquatic systems. In the case of toxic chemicals, terminal predators such as otter, mink. gulls, terns, eagles, ospreys, and turtles arc useful as integrative indicators of the status or health of the ecosystem,

Statutory and Regulatory Authority

Section 101(a)(2) of the CWA sets, as an interim goal of,

...wherever attainable . . water quality which provides for the protection and propagation of fish, shellfish, and *wildlife*...(emphasis added).

Section 304(a)(1) of the Act also requires EPA to:

...develop and publish criteria for water quality accurately reflecting ...the kind and extent of all identifiable effects on health and welfare including ...wildlife.

The Water Quality Standards Regulation reflect the statutory goals and requirements by requiring States to adopt, where attainable, the CWA section 101(a)(2) goal uses of protection and propagation of fish, shellfish, and wildlife (40 CFR 131.10), and to adopt water quality criteria sufficient to protect the designated use (40 CFR 131.11).

Wildlife Protection in Current Aquatic Criteria

Current water quality criteria methodology is designed to protect fish, benthic invertebrates, and zooplankton; however, there is a provision in the current aquatic life criteria guidelines (Appendix H (PDF) (18 pp, 1.5MBK)) that is intended to protect wildlife that consume aquatic organisms from the bioaccumulative potential of a compound. The final residue value can be based on either the FDA Action Level or a wildlife feeding study. However, if maximum permissible tissue concentration is not available from a wildlife feeding study, a final residue value cannot be derived and the criteria quantification procedure continues without further consideration of wildlife impacts. Historically, wildlife have been considered only after detrimental effects on wildlife populations have been observed in the environment (this occurred with relationship to DDT, selenium, and PCBs).

Wildlife Criteria Development

EPA's national wildlife criteria effort began following release of a 1987 Government Accounting Office study entitled *Wildlife Management - National Refuge Contamination Is Difficult To Confirm and Clean Up (GAO, 1987)*. After waterfowl deformities observed at Kesterson Wildlife Refuge were linked to selenium contamination in the water, Congress requested this study and recommended that "the Administrator of EPA, in close coordination with the Secretary of the Interior, develop water quality criteria for protecting wildlife and their refuge habitat."

In November of 1988, EPA's Environmental Research Laboratory in Corvallis sponsored a workshop entitled *Water Quality Criteria To Protect Wildlife Resources, (USEPA, 1989g)* which was co-chaired by EPA and the Fish and Wildlife Service (FWS). The workshop brought together 26 professionals from a variety of institutions, including EPA, FWS, State governments, academia, and consultants who had expertise in wildlife toxicity, aquatic toxicity, ecology, environmental risk assessment, and conservation. Efforts at the workshop focused on evaluating the need for, and developing a strategy for production of wildlife criteria. Two recommendations came out of that workshop:

1. The process by which ambient water quality criteria are established should be modified to consider effects on wildlife; and
2. chemicals should be prioritized based on their potential to adversely impact wildlife species.

Based on the workshop recommendations, screening level wildlife criteria (SLWC) were calculated for priority pollutants and chemicals of concern submitted by the FWS to gauge the extent of the problem by:

1. evaluating whether existing water quality criteria for aquatic life are protective of wildlife, and
2. prioritizing chemicals for their potential to adversely impact wildlife species.

There were 82 chemicals for which EPA had the necessary toxicity information as well as ambient water quality criteria, advisories, or lowest-observed-adverse-effect levels (LOAELs) to compare with the SLWC values. As would be expected, the majority of chemicals had SLWC larger than existing water quality criteria, advisories, or LOAELs for aquatic life. However, the screen identified classes of compounds for which current ambient water quality criteria may not be adequately protective of wildlife: chlorinated alkanes, benzenes, phenols, metals, DDT, and dioxins. Many of these compounds are produced in very large amounts and have a variety of uses (e.g., solvents, flame retardants, organic syntheses of fungicides and herbicides, and manufacture of plastics and textiles. The manufacture and use of these materials produce waste byproduct). Also, 5 of the 21 are among the top 25 pollutants identified at Superfund sites in 1985 (3 metals, 2 organics).

Following this initial effort, EPA held a national meeting in April 1992' to constructively discuss and evaluate proposed methodologies for deriving wildlife criteria to build consensus among the scientific community as to the most defensible scientifically approach(es) to be pursued by EPA in developing useful and effective wildlife criteria.

The conclusions of this national meeting were as follows:

- wildlife criteria should have a tissue-residue component when appropriate;
- peer-review of wildlife criteria and data sets should be used in their derivation;
- wildlife criteria should incorporate methods to establish site-specific wildlife criteria;
- additional amphibian and reptile toxicity data are needed;
- further development of inter-species toxicological sensitivity factors are needed; and
- criteria methods should measure biomarkers in conjunction with other studies.

On April 16, 1993, EPA proposed wildlife criteria in the *Water Quality Guidance for the Great Lakes System (58 F.R. 20802) (PDF)* (167 pp, 318K). The proposed wildlife criteria are based on the current EPA noncancer human health criteria approach. In this proposal, in addition to requesting comments on the proposed Great Lakes criteria and methods, EPA also requested comments on possible modifications of the proposed Great Lakes approach for consideration in the development of national wildlife criteria.

—3.5.6 Numeric Criteria for Wetlands

Extension of the EPA national 304(a) numeric aquatic life criteria to wetlands is recommended as part of a program to develop standards and criteria for wetlands. Appendices D (PDF) (60 pp, 4.5MB) and E (PDF) (51 pp, 2.9MB) provide an overview of the need for standards and criteria for wetlands. The 304(a) numeric aquatic life criteria are designed to be protective of aquatic life for surface waters and are generally applicable to most wetland types. Appendix E (PDF) (51 pp, 2.9MB) provides a possible approach, based on the site-specific guidelines, for detecting wetland types that might not be protected by direct application of national 304(a) criteria. The evaluation can be simple and inexpensive for those wetland types for which sufficient water chemistry and species assemblage data are available, but will be less useful for wetland types for which these data are not readily available. In Appendix E (PDF) (51 pp, 2.9MB), the site- specific approach is described and recommended for wetlands for which modification of the 304(a) numeric criteria are considered necessary. The results of this type of evaluation, combined with information on local or regional environmental threats, can be used to prioritize wetland types (and individual criteria) for further site-specific evaluations and/or additional data collection. Close coordination among regulatory agencies, wetland scientists, and criteria experts will be required.

3.6 Policy on Aquatic Life Criteria for Metals

It is the policy of the Office of Water that the use of dissolved metal to set and measure compliance with water quality standards is the recommended approach, because dissolved metal more closely approximates the bioavailable fraction of metal in the water column than does total recoverable metal. This conclusion regarding metals bioavailability is supported by a majority of the scientific community within and outside EPA. One reason is that a primary mechanism for water column toxicity is adsorption at the gill surface which requires metals to be in the dissolved form.

Until the scientific uncertainties are better resolved, a range of different risk management decisions can be justified by a State. EPA recommends that State water quality standards be based on dissolved metal--a conversion factor must be used in order to express the EPA criteria articulated as total recoverable as dissolved. (See the paragraph below for technical details on developing dissolved criteria.) EPA will also approve a State risk management decision to adopt standards based on total recoverable metal, if those standards are otherwise approvable as a matter of law. (*Office of Water Policy and Technical Guidance on Interpretation and Implementation of Aquatic Life Metals Criteria USEPA, 1993f) (PDF)* (49 pp, 2.6MB).

Updated Information

- Aquatic Life Criteria – This website provides basic information on 304(a) recommended criteria for the protection of aquatic life. The page also provides updates on criteria development.

Technical guidance and tools relating to Criteria

- Streamlined WER Procedure (PDF) (41 pp, 120K) – This document presents a streamlined procedure for determining site-specific values for a Water-Effect Ratio, a criteria adjustment factor accounting for the effect of site-specific water characteristics on pollutant bioavailability and toxicity to aquatic life.
- Modifications to Guidance Site-Specific Criteria (1997) (PDF) – This memo provides three documents that clarify and slightly modify the recommendations of the 1994 "Interim Guidance on Determination and Use of Water-Effect Ratios for Metals" (Appendix L) (PDF) (182 pp, 13.3MB).

—3.6.1 Background

The implementation of metals criteria is complex due to the site-specific nature of metals toxicity. This issue covers a number of areas including the expression of aquatic life criteria; total maximum daily loads (TMDLs), permits, effluent monitoring, and compliance; and ambient monitoring. The following Sections, based on the policy memorandum referenced above, provide additional guidance in each of these areas. Included in this Handbook as Appendix J (PDF) (30 pp, 1.4MB) are three guidance documents issued along with the Office of Water policy memorandum with additional technical details. They are: *Guidance Document on Expression of Aquatic Life Criteria as Dissolved Criteria (Attachment #2), Guidance Document on Dynamic Modeling and Translators (Attachment #3), and Guidance Document on Monitoring (Attachment #4) (PDF)* (30 pp, 1.4MB). These will be supplemented as additional information becomes available.

Since metals toxicity is significantly affected by site-specific factors, it presents a number of programmatic challenges. Factors that must be considered in the management of metals in the aquatic environment include: toxicity specific to effluent chemistry; toxicity specific to ambient water chemistry; different patterns of toxicity for different metals; evolution of the state of the science of metals toxicity, fate, and transport; resource limitations for monitoring, analysis, implementation. and research functions; concerns regarding some of the analytical data currently on record due to possible sampling and analytical contamination; and lack of standardized protocols for clean and ultraclean metals analysis. The States have the key role in the risk management process of balancing these factors in the management of water programs. The site-specific nature of this issue could be perceived as requiring a permit-by-permit approach to implementation. However, EPA believes that this guidance can be effectively implemented on a broader level, across any waters with roughly the same physical and chemical characteristics, and recommends that States work with the EPA with that perspective in mind.

—3.6.2 Expression of Aquatic Life Criteria

Dissolved vs. Total Recoverable Metal

A major issue is whether, and how, to use dissolved metal concentrations ("dissolved metal") or total recoverable metal concentrations ("total recoverable metal") III setting State water quality standards. In the past, States t1aL.c used both approaches when applying the same EPA Section 304(a) criteria guidance. Some older criteria documents may have facilitated those different approaches to interpretation of the criteria because the documents were somewhat equivocal with regards to analytical methods. The May 1992 interim guidance continued the policy that either approach was acceptable.

The position that the dissolved metals approach is more accurate has been questioned because it neglects the possible toxicity of particulate metal. It is true that some studies have indicated that particulate metals appear to contribute to the toxicity of metals, perhaps because of factors such as desorption of metals at the gill surface, but these same studies indicate the toxicity of particulate metal is substantially less than that of dissolved metal.

Furthermore, any error incurred from excluding the contribution of particulate metal will generally be compensated by other factors which make criteria conservative. For example, metals in toxicity tests are added as simple salts to relatively clean water. Due to the likely presence of a significant concentration of metals binding agents in many discharges and ambient waters, metals in toxicity tests would generally be expected to be more bioavailable than metals in discharges or in ambient waters.

If total recoverable metal is used for the purpose of specifying water quality standards, the lower bioavailability of particulate metal and lower bioavailability of sorbed metals as they are discharged may result in an overly conservative water quality standard. The use of dissolved metal in water quality standards gives a more accurate result in the water column. However, total recoverable measurements in ambient water have value, in that exceedences of criteria on a total recoverable basis are an indication that metal loadings could be a stress to the ecosystem, particularly in locations other than the water column (e.g., in the sediments).

The reasons for the potential consideration of total recoverable measurements include risk management considerations not covered by evaluation of water column toxicity alone. The ambient water quality criteria are neither designed nor intended to protect sediments, or to prevent effects in the food webs containing sediment dwelling organisms. A risk manager, however, may consider sediments and food chain effects and may decide to take a conservative approach for metals, considering that metals are very persistent chemicals. This conservative approach could include the use of total recoverable metal in water quality standards. However, since consideration of sediment impacts is not incorporated into the criteria methodology, the degree of conservatism inherent in the total recoverable approach is unknown. The uncertainty of metal impacts in sediments stem from the lack of sediment criteria and an imprecise understanding of the fate and transport of metals. EPA will continue to pursue research and other activities to close these knowledge gaps.

Dissolved Criteria

In the toxicity tests used to develop EPA metals criteria for aquatic life, some fraction of the metal is dissolved while some fraction is bound to particulate matter. The present criteria were developed using total recoverable metal measurements or measures expected to give equivalent results in toxicity tests, and are articulated as total recoverable. Therefore, in order to express the EPA criteria as dissolved, a total recoverable to dissolved conversion factor must be used. Attachment #2 in Appendix J provides guidance for calculating EPA dissolved criteria from the published total recoverable criteria. The data expressed as percentage metal dissolved are presented as recommended values and ranges. However, the choice within ranges is a State risk management decision. EPA has recently supplemented the data for copper and is proceeding to further supplement the data for copper and other metals. As testing is completed, EPA will make this information available and this is expected to reduce the magnitude of the ranges for some of the conversion factors provided. EPA also strongly encourages the application of dissolved criteria across a watershed or water-body, as technically sound and the best use of resources.

Site-Specific Criteria Modifications

While the above methods will correct some site-specific factors affecting metals toxicity, further refinements are possible. EPA has issued guidance for three site-specific criteria development methodologies: recalculation procedure, water-effect ratio (WER) procedure (called the indicator species procedure in previous guidance) and resident species procedure. (See Section 3.7 of this Chapter.)

In the National Toxics Rule (57 FR 60848, December 22, 1992), EPA recommended the WER as an optional method for site-specific criteria development for certain metals. EPA committed in the NTR preamble to provide additional guidance on determining the WERs. The *Interim Guidance on the Determination and Use of Water-Effects Ratios for Metals (PDF)* (182 pp, 13.1MB) was issued by EPA on February 22, 1994 and is intended to fulfill that commitment. This interim guidance supersedes all guidance concerning water-effect ratios and the recalculation procedure previously issued by EPA. This guidance is included as Appendix L to this Handbook.

In order to meet current needs, but allow for changes suggested by protocol users, EPA issued the guidance as "interim." EPA will accept WERs developed using this guidance, as well as by using other scientifically defensible protocols.

—3.6.3 Total Maximum Daily Loads (TMDLs) and National Pollutant Discharge Elimination System (NPDES) Permits

Dynamic Water Quality Modeling

Although not specifically part of the reassessment of water quality criteria for metals, dynamic or probabilistic models are another useful tool for implementing water quality criteria, especially for those criteria protecting aquatic life. These models provide another way to incorporate site-specific data. The *Technical Support Document for Water Quality-based Toxics Control* (TSD) (USEPA, 1991a) (PDF) (335 pp, 26.6MB) describes dynamic, as well as static (steady-state) models. Dynamic models make the best use of the specified magnitude, duration, and frequency of water quality criteria and, therefore, provide a more accurate representation of the probability that a water quality standard exceedence will occur. In contrast, steady-state models frequently apply a number of simplifying, worst case assumptions which makes them less complex but also less accurate than dynamic models.

Dynamic models have received increased attention over the last few years as a result of the widespread belief that steady-state modeling is over-conservative due to environmentally conservative dilution assumptions. This belief has led to the misconception that dynamic models will always lead to less stringent regulatory controls (e.g., NPDES effluent limits) than steady-state models, which is not true in every application of dynamic models. EPA considers dynamic models to be a more accurate approach to implementing water quality criteria and continues to recommend their use. Dynamic modeling does require a commitment of resources to develop appropriate data. (See Appendix J, Attachment #3 and the USEPA, 1991a for details on the use of dynamic models.)

Dissolved-Total Metal Translators

Expressing ambient water quality criteria for metals as the dissolved form of a metal poses a need to be able to translate from dissolved metal to total recoverable metal for TMDLs and NPDES permits. TMDLs for metals must be able to calculate: (1) dissolved metal in order to ascertain attainment of water quality standards, and (2) total recoverable metal in order to achieve mass balance necessary for permitting purposes.

EPA's NPDES regulations require that limits of metals in permits be stated as total recoverable in most cases (see 40 CFR § 122.45(c)) except when an effluent guideline specifies the limitation in another form of the metal, the approved analytical methods measure only dissolved metal, or the permit writer expresses a metals limit in another form (e.g., dissolved, valent specific, or total) when required to carry out provisions of the Clean Water Act. This is because the chemical conditions in ambient waters frequently differ substantially from those in the effluent, and there is no assurance that effluent particulate metal would not dissolve after discharge. The NPDES rule does not require that State water quality standards be expressed as total recoverable; rather, the rule requires permit writers to translate between different metal forms in the calculation of the permit limit so that a total recoverable limit can be established. Roth the TMDL and NPDES uses of water quality criteria require the ability to translate between dissolved metal and total recoverable metal. Appendix J, Attachment #3 provides guidance on this translation.

—3.6.4 Guidance on Monitoring

Use of Clean Sampling and Analytical Techniques

In assessing waterbodies to determine the potential for toxicity problems due to metals, the quality of the data used is an important issue. Metals data are used to determine attainment status for water quality standards, discern trends in water quality, estimate background loads for TMDLs, calibrate fate and transport models, estimate effluent concentrations (including effluent variability), assess permit compliance, and conduct research. The quality of trace level metal data, especially below 1 ppb, may be compromised due to contamination of samples during collection, preparation, storage, and analysis. Depending on the level of metal present, the use of "clean" and "ultraclean" techniques for sampling and analysis may be critical to accurate data for implementation of aquatic life criteria for metals.

The significance of the sampling and analysis contamination problem increases as the ambient and effluent metal concentration decreases and, therefore, problems are more likely in ambient measurements. "Clean" techniques refer to those requirements (or practices for sample collection and handling) necessary to product reliable analytical data in the part per billion (ppb) range. "Ultraclean" techniques refer to those requirements or practices necessary to produce reliable analytical data in the part per trillion (ppt) range. Because typical concentrations of metals in surface waters and effluents vary from one metal to another, the effect of contamination on the quality of metals monitoring data varies appreciably.

EPA plans to develop protocols on the use of clean and ultra-clean techniques and is coordinating with the United States Geological Survey (USGS) on this project, because USGS has been doing work on these techniques for some time, especially the sampling procedures. Draft protocols for clean techniques were presented at the Norfolk, VA analytical methods conference in the Spring of 1994 and final protocols are expected to be available in early 1995. The development of comparable protocols for ultra- clean techniques is underway and are expected to be available in late 1995. In developing these protocols, we will consider the costs of these techniques and will give guidance as to the situations where their use is necessary. Appendix L (PDF) (182 pp, 13.1MB), pp. 98-108 provide some general guidance on the use of clean analytical techniques. We recommend that this guidance be used by States and Regions as an interim step, while the clean and ultra-clean protocols are being developed.

Use of Historical Data

The concerns about metals sampling and analysis discussed above raise corresponding concerns about the validity of historical data. Data on effluent and ambient metal concentrations are collected by a variety of organizations including Federal agencies (e.g., EPA, USGS), State pollution control agencies and health departments, local government agencies, municipalities, industrial dischargers, researchers, and others. The data are collected for a variety of purposes as discussed above.

Concern about the reliability of the sample collection and analysis procedures is greatest where they have been used to monitor very low level metal concentrations. Specifically, studies have shown data sets with contamination problems during sample collection and laboratory analysis that have resulted in inaccurate measurements. For example, in developing a TMDL for New York Harbor, some historical ambient data showed extensive metals problems in the harbor, while other historical ambient data showed only limited metals problems. Careful resampling and analysis In 19921993 showed the latter view was correct. The key to producing accurate data is appropriate quality assurance (QA) and quality control (QC) procedures. EPA believes that most historical data for metals, collected and analyzed with appropriate QA and QC at levels of 1 ppb or higher, are reliable. The data used in development of EPA criteria are also considered reliable, both because they meet the above test and because the toxicity test solutions are created by adding known amounts of metals.

With respect to effluent monitoring reported by an NPDES permittee, the permittee is responsible for collecting and reporting quality data on a Discharge Monitoring Report (DMR). Permitting authorities should continue to consider the information reported to be true, accurate, and complete as certified by the permittee. Where the permittee becomes aware of new information specific to the effluent discharge that questions the quality of previously submitted DMR data, the permittee must promptly submit that information to the permitting authority. The permitting authority will consider all information submitted by the permittee in determining appropriate enforcement responses to monitoring/reporting and effluent violations. (See Appendix J (PDF) (30 pp, 1.4MB), Attachment #4 for additional details.)

3.7 Site-Specific Aquatic Life Criteria

The purpose of this section is to provide guidance for the development of site-specific water quality criteria which reflect local environmental conditions. Site-specific criteria are allowed by regulation and are subject to EPA review and approval. The Federal water quality standards regulation at section 13 1.1 l(b)(l)(ii) provides States with the opportunity to adopt water quality criteria that are " ...modified to reflect site-specific conditions." Site-specific criteria, as with all water quality criteria, must be based on a sound scientific rationale in order to protect the designated use. Existing guidance and practice are that EPA will approve site-specific criteria developed using appropriate procedures.

A site-specific criterion is intended to come closer than the national criterion to providing the intended level of protection to the aquatic life at the site, usually by taking into account the biological and/or chemical conditions (i.e., the species composition and/or water quality characteristics) at the site. The fact that the U.S. EPA has made these procedures available should not be interpreted as implying that the agency advocates that states derive site-specific criteria before setting state standards. Also, derivation of a site-specific criterion does not change the intended level of protection of the aquatic life at the site.

Updated Information

- Revised Deletion Process for the Site-Specific Recalculation Procedure for Aquatic Life Criteria (PDF) (15 pp, 200K) - This revision to the Recalculation Procedure is intended to make more consistent the process used to develop site-specific sensitivity distributions of aquatic organisms.
- Aquatic Life Criteria – This website provides basic information on 304(a) recommended criteria for the

—3.7.1 History of Site-Specific Criteria Guidance

National water quality criteria for aquatic life may be under- or over-protective if:

1. the species at the site are more or less sensitive than those included in the national criteria data set (e.g., the national criteria data set contains data for trout, salmon, penaeid shrimp, and other aquatic species that have been shown to be especially sensitive to some materials), or
2. physical and/or chemical characteristics of the site alter the biological availability and/or toxicity of the chemical (e.g., alkalinity, hardness, pH, suspended solids and salinity influence the concentration(s) of the toxic form(s) of some heavy metals, ammonia and other chemicals).

Therefore, it is appropriate that site-specific procedures address each of these conditions separately as well as the combination of the two. In the early 1980's, EPA recognized that laboratory-derived water quality criteria might not accurately reflect site-specific conditions and, in response, created three procedures to derive site- specific criteria. This Handbook contains the details of these procedures, referenced below.

1. The *Recalculation Procedure* is intended to take into account relevant differences between the sensitivities of the aquatic organisms in the national dataset and the sensitivities of organisms that occur at the site (see Appendix L (PDF) (182 pp, 13.1MB), pp. 90-97).
2. The *Water-Effect Ratio Procedure* (called the Indicator Species Procedure in the 1983 Water Quality Standards Handbook (USEPA, 1983a and in the Guidelines for Deriving Numerical Aquatic Site-Specific Water Quality Criteria by Modifying National Criteria 1984f provided for the use of a water-effect ratio (WER) that is intended to take into account relevant differences between the toxicities of the chemical in laboratory dilution water and in site water (see Appendix L (PDF) (182 pp, 13.1MB)).
3. The *Resident Species Procedure* intended to take into account both kinds of differences simultaneously (see Section 3.7.6).

These procedures were first published in the 1983 *Water Quality Standards Handbook* (USEPA, 1983a) and expanded upon in the *Guidelines for Deriving Numerical Aquatic Site-Specific Water Quality Criteria by Modifying National Criteria (USEPA, 1984f)*. Interest has increased in recent years as states have devoted more attention to chemical-specific water quality criteria for aquatic life. In addition, interest in water-effect ratios increased when they were integrated into some of the aquatic life criteria for metals that were promulgated for several states in the National Toxics Rule (57 E.B 60848. December 22, 1992). The *Office of Water Policy and Technical Guidance on Interpretation and Implementation of Aquatic Life Criteria for Metals (USEPA, 1993) (PDF)* (49 pp, 2.6MB) (see Section 3.6 of this Handbook) provided further guidance on site-specific criteria for metals by recommending the use of dissolved metals for setting and measuring compliance with water quality standards.

The early guidance concerning WERs (USEPA, 1983a; 1984f) contained few details and needed revision, especially to take into account newer guidance concerning metals. To meet this need, EPA issued *Interim Guidance on the Determination and Use of Water-Effect Ratios for Metals in 1994 (Appendix L (PDF)* (182 pp, 13.1MB)). Metals are specifically addressed in Appendix L because of the National Toxics Rule and because of current interest in aquatic life criteria for metals; although most of this guidance also applies to other pollutants, some obviously applies only to metals. Appendix L supersedes al1 guidance concerning water-effect ratios and the Indicator Species Procedure given in Chapter 4 of the *Water Quality Standards Handbook* (USEPA, l983a) and in *Guidelines for Deriving Numerical Aquatic Site-Specific Water Quality Criteria by Modifying National Criteria (USEPA, 1984f)*. Appendix L (PDF) (182 pp, 13.1MB) (p. 90-98) also supersedes the guidance in these earlier documents for the Recalculation Procedure for performing site-specific criteria modifications. The Resident Species Procedure remains essentially unchanged since 1983 (except for changes in the averaging periods to conform to the 1985 aquatic life criteria guidelines (USEPA. 198Sb) and is presented in Section 3.7.6, below.

The previous guidance concerning site-specific procedures did not allow the Recalculation Procedure and the WER procedure to be used together in the derivation of a site-specific aquatic life criterion; the only way to take into account both species composition and water quality characteristics in the determination of a site-specific criterion was to use the Resident Species Procedure. *A specific change contained in Appendix L is that, except in jurisdictions that are subject to the National Toxics Rule, the Recalculation Procedure and the WER Procedure may now be used together* provided that the recalculation procedure is performed first. Both the Recalculation Procedure and the WER Procedure are based directly on the guidelines for deriving national aquatic life criteria (USEPA 1985) (PDF) (18 pp, 1.5MB) and, when the two are used together, use of the Recalculation Procedure must be performed first because the Recalculation Procedure has specific implications concerning the determination of the WER.

protection of aquatic life. Page also provides updates of criteria development.

- Establishing Site-Specific Aquatic Life Criteria Equal to Natural Background (1997) (PDF) (4 pp, 200K) – This document describes EPA policy on the establishment of site specific numeric criteria on the basis of natural background conditions.
- A Framework for Defining and Documenting Natural Conditions for Development of Site-specific Natural Background Aquatic Life Criteria for Temperature, Dissolved Oxygen, and pH: Interim Document (2015) (PDF) (28 pp, 542K) - This interim technical document is intended as a framework to assist interested states and authorized tribes in developing a consistent, transparent, and scientifically-defensible approach for identifying and characterizing natural conditions for temperature, dissolved oxygen, and pH.

Endangered Species Act

- Water Quality Standards & the Endangered Species Act (2001) –This website links to a memorandum of agreement regarding the protection of endangered and threatened species under section 7 of the Endangered Species Act and the Clean Water Act's Water Quality Standards and National Pollution Discharge Elimination System programs.
- Fish & Wildlife Service Endangered Species Consultation Handbook (1998) – This website contains policies and procedures for conducting section 7 consultations and conferences.

—3.7.2 Preparing to Calculate Site-Specific Criteria

Adopting site-specific criteria in water quality standards is a State option--not a requirement. Moreover, EPA is not advocating that States use site-specific criteria development procedures for setting all aquatic life criteria as opposed to using the National Section 304(a) criteria recommendations. Site-specific criteria are not needed in all situations. When a State considers the possibility of developing site-specific criteria, it is essential to involve the appropriate EPA Regional office at the start of the project.

This early planning is also essential if it appears that data generation and testing may be conducted by a party other than the State or EPA. The State and EPA need to apply the procedures judiciously and must consider the complexity of the problem and the extent of knowledge available concerning the fate and effect of the pollutant under consideration. If site-specific criteria are developed without early EPA involvement in the planning and design of the task. the State may, expect EPA to take additional time to closely scrutinize the results before granting any approval to the formally adopted standards.

The following sequence of decisions need to be made before any of the procedures are initiated:

- verify that site-specific criteria are actually needed (e.g., that the use of clean sampling and/or analytical techniques, especially for metals, do not result in attainment of standards.)
- Define the site boundaries.
- Determine from the national criterion document and other sources if physical and/or chemical characteristics are known to affect the biological availability and/or toxicity of a material of interest.

- If data in the national criterion document and/or from other sources indicate that the range of sensitivity of the selected resident species to the material of interest is different from the range for the species in the national criterion document, and variation in physical and/or chemical characteristics of the site water is not expected to be a factor, use the *Recalculation Procedure* (Section 3.7.4).
- If data in the national criterion document and/or from other sources indicate that physical and/or chemical characteristics of the site water may affect the biological availability and/or toxicity of the material of interest, and the selected resident species range of sensitivity is similar to that for the species in the national criterion document, use the *Water-Effect Ratio Procedure* (Section 3.7.5).
- If data in the national criterion document and/or from other sources indicated that physical and/or chemical characteristics of the site water may affect the biological availability and/or toxicity of the material of interest, and the selected resident species range of sensitivity is *different* from that for the species in the national criterion document, and if both these differences are to be taken into account, use the *Recalculation Procedure in conjunction with the Water-Effect Ratio Procedure* or use the *Resident Species Procedure* (Section 3.7.6).

—3.7.3 Definition of a Site

Since the rationales for site-specific criteria are usually based on potential differences in species sensitivity, physical and chemical characteristics of the water, or a combination of the two, the concept of site must be consistent with this rationale.

In the general context of site-specific criteria, a "site" may be a state, region, watershed, water-body, or segment of a waterbody. The site-specific criterion is to be derived to provide adequate protection for the entire site, however the site is defined.

If water quality effects on toxicity are not a consideration, the site can be as large as a generally consistent biogeographic zone permits. For example, large portions of the Chesapeake Bay, Lake Michigan, or the Ohio River may be considered as one site if their respective aquatic communities do not vary substantially. However, when a site-specific criterion is derived using the Recalculation Procedure, all species that "occur at the site" need to be taken into account when deciding what species, if any, are to be deleted from the dataset. Unique populations or less sensitive uses within sites may justify a designation as a distinct site.

If the species of a site are toxicologically comparable to those in the national criteria data set for a material of interest, and physical and/or chemical water characteristics are the only factors supporting modification of the national criteria, then the site can be defined on the basis of expected changes in the material's biological availability and/or toxicity due to physical and chemical variability of the site water. However, when a site-specific criterion is derived using a WER, the WER is to be adequately protective of the entire site. If, for example. a site-specific criterion is being derived for an estuary, WERs could be determined using samples of the surface water obtained from various sampling stations, which, to avoid confusion, should not be called "sites". If all the WERs were sufficiently similar, one site-specific criterion could be derived to apply to the whole estuary. If the WERs were sufficiently different, either the lowest WER could be used to derive a site-specific criterion for the whole estuary, or the data might indicate that the estuary should be divided into two or more sites, each with its own criterion.

—3.7.4 The Recalculation Procedure

The Recalculation Procedure is intended to cause a site-specific criterion to appropriately differ from a national aquatic life criterion if justified by demonstrated pertinent toxicological differences between the aquatic species that occur at the site and those that were used in the derivation of the national criterion. There are at least three reasons why such differences might exist between the two sets of species.

- First, the national dataset contains aquatic species that are sensitive to many pollutants, but these and comparably sensitive species might not occur at the site.
- Second, a species that is critical at the site might be sensitive to the pollutant and require a lower criterion. (A critical species is a species that is commercially or recreationally important at the site, a species that exists at the site and is listed as threatened or endangered under section 4 of the Endangered Species Act, or a species for which there is evidence that the loss of the species from the site is likely to cause an unacceptable impact on a commercially or recreationally important species, a threatened or endangered species, the abundances of a variety of other species, or the structure or function of the community.)
- Third, the species that occur at the site might represent a narrower mix of species than those in the national dataset due to a limited range of natural environmental conditions.

The procedure presented in Appendix L (PDF) (182 pp, 13.1MB), pp. 90-98 is structured so that corrections and additions can be made to the national dataset without the deletion process being used to take into account taxa that do not occur at the site; in effect, this procedure makes it possible to update the national aquatic life criterion. All corrections and additions that have been approved by EPA are required, whereas use of the deletion process is optional. The deletion process may not be used to remove species from the criterion calculation that are not currently present at a site due to degraded conditions.

The Recalculation Procedure is more likely to result in lowering a criterion if the net result of addition and deletion is to decrease the number of genera in the dataset, whereas the procedure is more likely to result in raising a criterion if the net result of addition and deletion is to increase the number of genera in the dataset.

For the lipid soluble chemicals whose national Final Residue Values are based on Food and Drug Administration (FDA) action levels, adjustments in those values based on the percent lipid content of resident aquatic species is appropriate for the derivation of site-specific Final Residue Values. For lipid-soluble materials, the national Final Residue Value is based on an average 11 percent lipid content for edible portions for the freshwater chinook salmon and lake trout and an average of 10 percent lipids for the edible portion for saltwater Atlantic herring. Resident species of concern may have higher (e.g., Lake Superior siscowet, a race of lake trout) or lower (e.g., many sport fish) percent lipid content than used for the national Final Residue Value.

For some lipid-soluble materials such as polychlorinated biphenyls (PCB) and DDT, the national Final Residue Value is based on wildlife consumers of fish and aquatic invertebrate species rather than an FDA action level because the former provides a more stringent residue level. See the National Guidelines (USEPA, 1985b) (PDF) (59 pp, 557K) for details.

For the lipid-soluble materials whose national Final Residue Values are based on wildlife effects, the limiting wildlife species (mink for PCB and brown pelican for DDT) are considered acceptable surrogates for resident avian and mammalian species (e.g., herons, gulls, terns, otter, etc.) Conservatism is appropriate for those two chemicals, and no less restrictive modification of the national Final Residue Value is appropriate. The site-specific Final Residue Value would be the same as the national value.

—3.7.5 The Water-Effect Ratio (WER) Procedure

The guidance on the Water-Effect Ratio Procedure presented in Appendix L (PDF) (182 pp, 13.1MB), is intended to produce WERs that may be used to derive site-specific aquatic life criteria from most national and state aquatic life criteria that were derived from laboratory toxicity data.

As indicated in Appendix L (PDF) (182 pp, 13.1MB), the determination of a water-effect ratio may require substantial resources. A discharger should consider cost-effective, preliminary measures described in Appendix L (e.g., use of "clean" sampling and chemical analytical techniques especially for metals, or in non-NTR States, a recalculated criterion) to determine if an indicator species site-specific criterion is really needed. In many instances, use of these other measures may eliminate the need for deriving water-effect ratios. The methods described in the 1994 interim guidance (Appendix L (PDF) (182 pp, 13.1MB)) should be sufficient to develop site-specific criteria that resolve concerns of dischargers when there appears to be no instream toxicity but, where (a) a discharge appears to exceed existing or proposed water quality-based permit limits, or (b) an instream concentration appears to exceed an existing or proposed water quality criterion.

WERs obtained using the methods described in Appendix L should only be used to adjust aquatic life criteria that were derived using laboratory toxicity tests. WERs determined using the methods described herein cannot be used to adjust the residue-based mercury Criterion Continuous Concentration (CCC) or the field-based selenium freshwater criterion.

Except in jurisdictions that are subject to the NTR, the WERs may also be used with site-specific aquatic life criteria that are derived using the Recalculation Procedure described in Appendix L (p.90).

Water-Effect Ratios in the Derivation of Site-Specific Criteria

A central question concerning WERs is whether their use by a State results in a site-specific criterion subject to EPA review and approval under Section 303(c) of the Clean Water Act?

Derivation of a water-effect ratio by a State is a site-specific criterion adjustment subject to EPA review and approval/disapproval under Section 303(c). There are two options by w.hich this review can be accomplished.

Option 1

A State may derive and submit each individual water-effect ratio determination to EPA for review and approval. This would be accomplished through the normal review and revision process used by a State.

Option 2

A State can amend its water quality standards to provide a formal procedure which includes derivation of water-effect ratios, appropriate definition of sites, and enforceable monitoring provisions to assure that designated uses are protected. Both this procedure and the resulting criteria would be subject to full public participation requirements. EPA would review and approve/disapprove this protocol as a revised standard as part of the State's triennial review/revision. After adoption of the procedure, public review of a site-specific criterion could be accomplished in conjunction with the public review required for permit issuance. For public information, EPA recommends that once a year the State publish a list of site-specific criteria.

An exception to this policy applies to the waters of the jurisdictions included in the National Toxics Rule. The EPA *review* is not required for the jurisdictions included in the National Toxics Rule where EPA established the procedure for the State for application to the criteria promulgated. The National Toxics Rule was a formal rulemaking process (with notice and comment) in which EPA pre-authorized the use of a correctly applied water-effect ratio. That same process has not yet taken place in States not included in the National Toxics Rule.

However, the National Toxics Rule does not affect State authority to establish scientifically defensible procedures to determine Federally authorized WERs. to certify those WERs in NPDFS permit proceedings, or to deny their application based on the State's risk management analysis.

As described in Section 12 1.36(b)(iii) of the water quality standards regulation (the official regulatory reference to the National Toxics Rule), the water- effect ratio is a site-specific calculation. As indicated on page 60866 of the preamble to the National Toxics Rule, the rule was constructed as a rebuttable presumption. The water-effect ratio is assigned a value of 1.O until a different water- effect ratio is derived from suitable tests representative of conditions in the affected waterbody. It is the responsibility of the State to determine whether to rebut the assumed value of 1O in the National Toxics Rule and apply another value of the water-effect ratio in order to establish a site-specific criterion. The site-specific criterion is then used to develop appropriate NPDES permit limits. The rule thus provides a State with the flexibility to derive an appropriate site-specific criterion for specific waterbodies.

As a point of emphasis, although a water-effect ratio affects permit limits for individual dischargers, it is the State in all cases that determines if derivation of a site-specific criterion based on the water-effect ratio is allowed and it is the State that ensures that the calculations and data analysis are done completely and correctly.

—3.7.6 The Resident Species Procedure

The resident Species Procedure for the derivation of a site-specific criterion accounts for differences in resident species sensitivity d differences in biological availability and/or toxicity of a material due to variability in physical and chemical characteristics of a site water. Derivation of the site-specific criterion maximum concentration (CMC) and site-specific criterion continuous concentration (CCC) are accomplished after the complete acute toxicity minimum data set requirements have been met by conducting tests with resident species in site water. Chronic tests may also be necessary. This procedure is designed to compensate concurrently for any real differences between the sensitivity range of species represented in the national data set and for site water which may markedly affect the biological availability and/or toxicity of the material of interest.

Certain families of organisms have been specified in the National Guidelines acute toxicity minimum data set (e.g., Salmonidae in fresh water and Penaeidae or Mysidae in salt water); if this or any other requirement cannot be met because the family or other group (e.g., insect or benthic crustacean) in fresh water is not represented by resident species, select a substitute(s) from a sensitive family represented by one or more resident species and meet the 8 family minimum data set requirement. If all the families at the site have been tested and the minimum data set requirements have not been met, use the most sensitive resident family mean acute value as the site-specific Final Acute Value.

To derive the criterion maximum concentration divide the site-specific Final Acute Value by two. The site-specific Final Chronic Value can be obtained as described in the Appendix L (PDF) (182 pp, 13.1MB). The lower of the site-specific Final Chronic Value (as described in the recalculation procedure - Appendix L, p. 90) and the recalculated site-specific Final Residue Value becomes the site- specific criterion continuous concentration unless plant or other data (including data obtained from the site-specific tests) indicates a lower value is appropriate. If a problem is identified, judgment should be used in establishing the site-specific criterion.

The frequency of testing (e.g., the need for seasonal testing) will be related to the variability of the physical and chemical characteristics of site water as it is expected to affect the biological availability and/or toxicity of the material of interest. As the variability increases, the frequency of testing will increase. Many of the limitations discussed for the previous two procedures would also apply to this procedure.

Endnotes

1. Proceedings in production.

(9/15/93)

Pages: 3-1–3-45

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EPA United States Environmental Protection Agency

http://water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm#altable

Water: Current Water Quality Criteria

You are here: Water » Science & Technology » Surface Water Standards & Guidance » Water Quality Standards » Water Quality Criteria » National Recommended Water Quality Criteria

National Recommended Water Quality Criteria

EPA's compilation of national recommended water quality criteria is presented as a summary table containing recommended water quality criteria for the protection of aquatic life and human health in surface water for approximately 150 pollutants. These criteria are published pursuant to Section 304(a) of the Clean Water Act (CWA) and provide guidance for states and tribes to use in adopting water quality standards.

- **Aquatic Life Criteria Table**
- **Human Health Criteria Table**
- **DRAFT: Updated National Recommended Water Quality Criteria - Human Health**
- **Organoleptic Effects** (e.g., taste and odor)
- **Additional Notes**
- **Appendix A**—Conversion Factors for Dissolved Metals
- **Appendix B**—Parameters for Calculating Freshwater Dissolved Metals Criteria That Are Hardness-Dependent
- **Gold & Red Books**

Quick Navigation

- Previous versions of National Recommended Water Quality Criteria Table
- Chemical-specific criteria documents from the 1980s
- Water quality standards
- Human Health Criteria Calculation Matrix (PDF) (23 pp, 445K, About PDF)

Aquatic Life Criteria Table

Pollutant	CAS Number	P/NP*	Freshwater CMC1 (acute) (μg/L)	Freshwater CCC1 (chronic) (μg/L)	Saltwater CMC1 (acute) (μg/L)	Saltwater CCC1 (chronic) (μg/L)	Publication Year
Acrolein	107028	P	3ug/L	3ug/L			2009
Aesthetic Qualities	—	NP	NARRATIVE STATEMENT—SEE DOCUMENT				1986
Aldrin	309002	P	3.0 G		1.3 G		1980
Alkalinity	—	NP		20000 C			1986
alpha-Endosulfan	959988	P	0.22 G, Y	0.056 G, Y	0.034 G, Y	0.0087 G, Y	1980
Aluminum pH 6.5 – 9.0	7429905	NP	750 I	87 I, S			1988
Ammonia	7664417	NP	FRESHWATER CRITERIA ARE pH, Temperature and Life-stage DEPENDENT SALTWATER CRITERIA ARE pH AND TEMPERATURE DEPENDENT				2013 1989
Arsenic	7440382	P	340 A, D	150 A, D	69 A, D	36 A, D	1995
Bacteria	—	NP	FOR PRIMARY RECREATION AND SHELLFISH USES—SEE DOCUMENT				1986
beta-Endosulfan	33213659	P	0.22 G, Y	0.056 G, Y	0.034 G, Y	0.0087 G, Y	1980
Boron	—	NP	NARRATIVE STATEMENT—SEE DOCUMENT				1986
Carbaryl	63252	NP	2.1	2.1	1.6		2012
Cadmium	7440439	P	2.0 D, E	0.25 D, E	40 D	8.8 D	2001
Chlordane	57749	P	2.4 G	0.0043 G	0.09 G	0.004 G	1980
Chloride	16887006	NP	860000	230000			1986
Chlorine	7782505	NP	19	11	13	7.5	1986
Chloropyrifos	2921882	NP	0.083	0.041	0.011	0.0056	1986
Chromium (III)	16065831	P	570 D, E	74 D, E			1995
Chromium (VI)	18540299	P	16 D	11 D	1,100 D	50 D	1995
Color	—	NP	NARRATIVE STATEMENT—SEE DOCUMENT				1986
Copper	7440508	P	Freshwater criteria calculated using the BLM mm - See Document		4.8 D, cc	3.1 D, cc	2007
Cyanide	57125	P	22 Q	5.2 Q	1 Q	1 Q	1985
Demeton	8065483	NP		0.1 C		0.1 C	1985
Diazinon	333415	NP	0.17ug/L	0.17ug/L	0.82ug/L	0.82ug/L	2005
Dieldrin	60571	P	0.24	0.056 O	0.71 G	0.0019 G	1995

Endrin	72208	P	0.086	0.036 O	0.037 G	0.0023 G	1995
gamma-BHC (Lindane)	58899	P	0.95		0.16 G		1995
Gases, Total Dissolved	—	NP	NARRATIVE STATEMENT—SEE DOCUMENT C				1986
Guthion	86500	NP		0.01 C		0.01 C	1986
Hardness	—	NP	NARRATIVE STATEMENT—SEE DOCUMENT				1986
Heptachlor	76448	P	0.52 G	0.0038 G	0.053 G	0.0036 G	1980
Heptachlor Epoxide	1024573	P	0.52 G, V	0.0038 G, V	0.053 G, V	0.0036 G, V	1981
Iron	7439896	NP		1000 C			1986
Lead	7439921	P	65 D, E	2.5 D, E	210 D	8.1 D	1980
Malathion	121755	NP		0.1 C		0.1 C	1986
Mercury Methylmercury	7439976 22967926	P	1.4 D, hh	0.77 D, hh	1.8 D, ee, hh	0.94 D, ee, hh	1995
Methoxychlor	72435	NP		0.03 C		0.03 C	1986
Mirex	2385855	NP		0.001 C		0.001 C	1986
Nickel	7440020	P	470 D, E	52 D, E	74 D	8.2 D	1995
Nonylphenol	84852153	NP	28ug/L	6.6ug/L	7ug/L	1.7ug/L	2005
Nutrients	—	NP	See EPA's Ecoregional criteria for Total Phosphorus, Total Nitrogen, Chlorophyll *a* and Water Clarity (Secchi depth for lakes; turbidity for streams and rivers) (& Level III Ecoregional criteria)				
Oil and Grease	—	NP	NARRATIVE STATEMENT—SEE DOCUMENT C				1986
Oxygen, Dissolved Freshwater Oxygen, Dissolved Saltwater	7782447	NP	WARMWATER AND COLDWATER MATRIX—SEE DOCUMENT SALTWATER—SEE DOCUMENT				1986
Parathion	56382	NP	0.065 I	0.013 I			1995
Pentachlorophenol	87865	P	19 F	15 F	13	7.9	1995
pH	—	NP		6.5 – 9 C		6.5 – 8.5 C, P	1986
Phosphorus Elemental	7723140	NP					1986
Polychlorinated Biphenyls (PCBs)		P		0.014 N		0.03 N	
Selenium	7782492	P	L, R	5.0 R	290 D, dd	71 D, dd	1999
Silver	7440224	P	3.2 D, E		1.9 D		1980
Solids Suspended and Turbidity	—	NP	NARRATIVE STATEMENT—SEE DOCUMENT C				1986
Sulfide-Hydrogen Sulfide	7783064	NP		2.0 C		2.0 C	1986
Tainting Substances	—	NP	NARRATIVE STATEMENT—SEE DOCUMENT				1986
Temperature	—	NP	SPECIES DEPENDENT CRITERIA—SEE DOCUMENT M				1986
Toxaphene	8001352	P	0.73	0.0002	0.21	0.0002	1986
Tributyltin (TBT)	—	NP	0.46	0.072	0.42	0.0074	2004
Zinc	7440666	P	120 D, E	120 D, E	90 D	81 D	1995
4,4'-DDT	50293	P	1.1 G, ii	0.001 G, ii	0.13 G, ii	0.001 G, ii	1980

***P/NP – Indicates either a Priority Pollutant (P) or a Non Priority Pollutant (NP).**

Footnotes

A This recommended water quality criterion was derived from data for arsenic (III), but is applied here to total arsenic, which might imply that arsenic (III) and arsenic (V) are equally toxic to aquatic life and that their toxicities are additive. No data are known to be available concerning whether the toxicities of the forms of arsenic to aquatic organisms are additive. Please consult the criteria document for details.

C The derivation of this value is presented in the Red Book (EPA 440/9-76-023, July, 1976). The CCC of 20mg/L is a minimum value except where alkalinity is naturally lower, in which case the criterion cannot be lower than 25% of the natural level.

D Freshwater and saltwater criteria for metals are expressed in terms of the dissolved metal in the water column. See "Office of Water Policy and Technical Guidance on Interpretation and Implementation of Aquatic Life Metals Criteria (PDF)," (49 pp, 3MB) October 1, 1993, by Martha G. Prothro, Acting Assistant Administrator for Water, available on NSCEP's web site and 40CFR§131.36(b)(1). Conversion Factors applied in the table can be found in Appendix A to the Preamble- Conversion Factors for Dissolved Metals.

E The freshwater criterion for this metal is expressed as a function of hardness (mg/L) in the water column. The value given here corresponds to a hardness of 100 mg/L. Criteria values for other hardness may be calculated per the equation presented in the criteria document.

F Freshwater aquatic life values for pentachlorophenol are expressed as a function of pH. Values displayed in table correspond to a pH of 7.8.

G This Criterion is based on 304(a) aquatic life criterion issued in 1980, and was issued in one of the following documents: Aldrin/Dieldrin (PDF) (153 pp, 7.3MB) (EPA 440/5-80-019), Chlordane (PDF) (68 pp, 3.1MB) (EPA 440/5-80-027), DDT (PDF) (175 pp, 8 3MB) (EPA 440/5-80-038), Endosulfan (PDF) (155 pp, 7.3MB) (EPA 440/5-80-046), Endrin (PDF) (103 pp, 4.6MB) (EPA 440/5-80-047), Heptachlor (PDF) (114 pp, 5.4MB) (EPA 440/5-80-052), Hexachlorocyclohexane (PDF) (109 pp, 4.8MB) (EPA 440/5-80-054), Silver (EPA 440/5-80-071). The Minimum Data Requirements and derivation procedures were different in the 1980 Guidelines than in the 1985 Guidelines (PDF) (104 pp, 3.3MB). If evaluation is to be done using an averaging period, the acute criteria values given should be divided by 2 to obtain a value that is more comparable to a CMC derived using the 1985 Guidelines.

I This value for aluminum is expressed in terms of total recoverable metal in the water column.

J This value was derived using the GLI Guidelines (60 FR 15393-15399, March 23, 1995; 40CFR132 Appendix A); the differences between the 1985 Guidelines and the GLI Guidelines are explained on page iv of the 1995 Updates. No decision concerning this criterion was affected by any considerations that are specific to the Great Lakes.

L The CMC = 1/[(f1/CMC1) + (f2/CMC2)] where f1 and f2 are the fractions of total selenium that are treated as selenite and selenate, respectively, and CMC1 and CMC2 are 185.9 ug/l and 12.82 ug/l, respectively. However, based on findings from a February 2009 SETAC Pellston Workshop on Ecological Assessment of Selenium in the Aquatic Environment, diet is the primary pathway of selenium exposure to aquatic life, and traditional methods for predicting toxicity on the basis of exposure to dissolved concentrations are not appropriate for selenium. (To view a summary of the SETAC Pellston workshop including key findings visit http://www.setac.org/resource/resmgr/publications_and_resources/selsummary.pdf).

M U.S. EPA. 1973. Water Quality Criteria 1972. EPA-R3-73-033. National Technical Information Service, Springfield, VA.; U.S. EPA. 1977. Temperature Criteria for Freshwater Fish: Protocol and Procedures. EPA 600/3-77-061. National Technical Information Service, Springfield, VA.

N This criterion applies to total PCBs, (e.g., the sum of all congener or all isomer or homolog or Aroclor analyses.)

O The derivation of the CCC for this pollutant (Endrin) did not consider exposure through the diet, which is probably important for aquatic life occupying upper trophic levels.

P According to page 181 of the Red Book:

For open ocean waters where the depth is substantially greater than the euphotic zone, the pH should not be changed more than 0.2 units from the naturally occurring variation or any case outside the range of 6.5 to 8.5. For shallow, highly productive coastal and estuarine areas where naturally occurring pH variations approach the lethal limits of some species, changes in pH should be avoided but in any case should not exceed the limits established for fresh water, i.e., 6.5-9.0.

Q This recommended water quality criterion is expressed as ug free cyanide (as CN)/L.

R EPA is in the process of updating this criterion to reflect the latest scientific information. See EPA's Aquatic Life Criterion - Selenium website for more information.

S There are three major reasons why the use of Water-Effect Ratios might be appropriate.

1. The value of 87 µg/l is based on a toxicity test with the striped bass in water with pH = 6.5–6.6 and hardness <10 mg/L. Data in "Aluminum Water-Effect Ratio for the 3M Plant Effluent Discharge, Middleway, West Virginia" (May 1994) indicate that aluminum is substantially less toxic at higher pH and hardness, but the effects of pH and hardness are not well quantified at this time.
2. In tests with the brook trout at low pH and hardness, effects increased with increasing concentrations of total aluminum even though the concentration of dissolved aluminum was constant, indicating that total recoverable is a more appropriate measurement than dissolved, at least when particulate aluminum is primarily aluminum hydroxide particles. In surface waters, however, the total recoverable procedure might measure aluminum associated with clay particles, which might be less toxic than aluminum associated with aluminum hydroxide.
3. EPA is aware of field data indicating that many high quality waters in the U.S. contain more than 87 g aluminum/L, when either total recoverable or dissolved is measured.

V This value was derived from data for heptachlor and the criteria document provides insufficient data to estimate the relative toxicities of heptachlor and heptachlor epoxide.

Y This value was derived from data for endosulfan and is most appropriately applied to the sum of alpha-endosulfan and beta-endosulfan.

cc When the concentration of dissolved organic carbon is elevated, copper is substantially less toxic and use of Water-Effect Ratios might be appropriate.

dd The selenium criteria document (EPA 440/5-87-006, September 1987) provides that if selenium is as toxic to saltwater fishes in the field as it is to freshwater fishes in the field, the status of the fish community should be monitored whenever the concentration of selenium exceeds 5.0 µg/L in salt water because the saltwater CCC does not take into account uptake via the food chain.

ee This recommended water quality criterion was derived on page 43 of the mercury criteria document (PDF) (144 pp, 6.4MB) (EPA 440/5-84-026, January 1985). The saltwater CCC of 0.025 ug/L given on page 23 of the criteria document is based on the Final Residue Value procedure in the 1985 Guidelines. Since the publication of the Great Lakes Aquatic Life Criteria Guidelines in 1995 (60 FR 15393-15399, March 23, 1995), the Agency no longer uses the Final Residue Value procedure for deriving CCCs for new or revised 304(a) aquatic life criteria.

hh This recommended water quality criterion was derived from data for inorganic mercury (II), but is applied here to total mercury. If a substantial portion of the mercury in the water column is methylmercury, this criterion will probably be under protective. In addition, even though inorganic mercury is converted to methylmercury and methylmercury bioaccumulates to a great extent, this criterion does not account for uptake via the food chain because sufficient data were not available when the criterion was derived.

ii This criterion applies to DDT and its metabolites (i.e., the total concentration of DDT and its metabolites should not exceed this value).

mm The available toxicity data, when evaluated using the procedures described in the "Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses" indicate that freshwater aquatic life should be protected if the 24-hour average and four-day average concentrations do not respectively exceed the acute and chronic criteria concentrations calculated by the Biotic Ligand Model.

Human Health Criteria Table

DRAFT: Updated National Recommended Water Quality Criteria - Human Health

Pollutant	CAS Number	P/NP*	Human Health for the consumption of Water + Organism (µg/L)	Organism Only (µg/L)	Publication Year
Acenaphthene	83329	P	670 B, U	990 B, U	2002
Acrolein	107028	P	6 ll	9 ll	2009
Acrylonitrile	107131	P	0.051 B, C	0.25 B, C	2002
Aldrin	309002	P	0.000049 B, C	0.000050 B, C	2002
alpha-BHC	319846	P	0.0026 B, C	0.0049 B, C	2002
alpha-Endosulfan	959988	P	62 B	89 B	2002
Anthracene	120127	P	8,300 B	40,000 B	2002
Antimony	7440360	P	5.6 B	640 B	2002
Arsenic	7440382	P	0.018 C, M, S	0.14 C, M, S	1992
Asbestos	1332214	P	7 million fibers/L I		1991
Barium	7440393	NP	1,000 A		1986
Benzene	71432	P	2.2 B, C	51 B, C	2002
Benzidine	92875	P	0.000086 B, C	0.00020 B, C	2002
Benzo(a) Anthracene	56553	P	0.0038 B, C	0.018 B, C	2002
Benzo(a) Pyrene	50328	P	0.0038 B, C	0.018 B, C	2002
Benzo(b) Fluoranthene	205992	P	0.0038 B, C	0.018 B, C	2002
Benzo(k) Fluoranthene	207089	P	0.0038 B, C	0.018 B, C	2002
Beryllium	7440417	P	Z		
beta-BHC	319857	P	0.0091 B, C	0.017 B, C	2002
beta-Endosulfan	33213659	P	62 B	89 B	2002
Bis(2-Chloroethyl) Ether	111444	P	0.030 B, C	0.53 B, C	2002
Bis(2-Chloroisopropyl) Ether	108601	P	1,400 B	65,000 B	2002
Bis(2-Ethylhexyl) Phthalate	117817	P	1.2 B, C	2.2 B, C	2002
Bromoform	75252	P	4.3 B, C	140 B, C	2002
Butylbenzyl Phthalate	85687	P	1,500 B	1,900 B	2002
Cadmium	7440439	P	Z		
Carbon Tetrachloride	56235	P	0.23 B, C	1.6 B, C	2002
Chlordane	57749	P	0.00080 B, C	0.00081 B, C	2002
Chlorobenzene	108907	P	130 Z, U	1,600 U	2003
Chlorodibromomethane	124481	P	0.40 B, C	13 B, C	2002
Chloroform	67663	P	5.7 C, P	470 C, P	2002
	94757	NP	100 Z		1986

Chlorophenoxy Herbicide (2,4-D)					
Chromium (III)	16065831	P	Z Total		
Chromium (VI)	18540299	P	Z Total		
Chrysene	218019	P	0.0038 B, C	0.018 B, C	2002
Copper	7440508	P	1,300 U		1992
Cyanide	57125	P	140 jj	140 jj	2003
Dibenzo(a,h)Anthracene	53703	P	0.0038 B, C	0.018 B, C	2002
Dichlorobromomethane	75274	P	0.55 B, C	17 B,C	2002
Dieldrin	60571	P	0.000052 B, C	0.000054 B, C	2002
Diethyl Phthalate	84662	P	17,000 B	44,000 B	2002
Dimethyl Phthalate	131113	P	270,000	1,100,000	2002
Di-n-Butyl Phthalate	84742	P	2,000 B	4,500 B	2002
Dinitrophenols	25550587	NP	69	5300	2002
Endosulfan Sulfate	1031078	P	62 B	89 B	2002
Endrin	72208	P	0.059	0.060	2003
Endrin Aldehyde	7421934	P	0.29 B	0.30 B, H	2002
Ether, Bis(Chloromethyl)	542881	NP	0.00010 C	0.00029 C	2002
Ethylbenzene	100414	P	530	2,100	2003
Fluoranthene	206440	P	130 B	140 B	2002
Fluorene	86737	P	1,100 B	5,300 B	2002
gamma-BHC (Lindane)	58899	P	0.98	1.8	2003
Heptachlor	76448	P	0.000079 B, C	0.000079 B, C	2002
Heptachlor Epoxide	1024573	P	0.000039 B, C	0.000039 B, C	2002
Hexachlorobenzene	118741	P	0.00028 B, C	0.00029 B, C	2002
Hexachlorobutadiene	87683	P	0.44 B, C	18 B, C	2002
Hexachlorocyclo-hexane-Technical	608731		0.0123 H	0.0414H	
Hexachlorocyclopentadiene	77474	P	40 U	1,100 U	2003
Hexachloroethane	67721	P	1.4 B, C	3.3 B, C	2002
Ideno(1,2,3-cd)Pyrene	193395	P	0.0038 B, C	0.018 B, C	2002
Isophorone	78591	P	35 B, C	960 B, C	2002
Manganese	7439965	NP	50 O	100 A	
Methylmercury	22967926	P		0.3 mg/kg J	2001
Methoxychlor	72435	NP	100 A, Z		1986
Methyl Bromide	74839	P	47 B	1,500 B	2002
Methylene Chloride	75092	P	4.6 B, C	590 B,C	2002
Nickel	7440020	P	610 B	4,600 B	1998
Nitrates	14797558	NP	10,000 A		1986
Nitrobenzene	98953	P	17 B	690 B, H, U	2002
Nitrosamines	—	NP	0.0008	1.24	1980
Nitrosodibutylamine, N	924163	NP	0.0063 C	0.22 C	2002
Nitrosodiethylamine, N	55185	NP	0.0008 C	1.24 C	2002
Nitrosopyrrolidine, N	930552	NP	0.016 C	34 C	2002
N-Nitrosodimethylamine	62759	P	0.00069 B, C	3.0 B, C	2002
N-Nitrosodi-n-Propylamine	621647	P	0.0050 B, C	0.51 B, C	2002

N-Nitrosodiphenylamine	86306	P	3.3 B, C	6.0 B, C	2002
Nutrients	—	NP	See EPA's Ecoregional criteria for Total Phosphorus, Total Nitrogen, Chlorophyll *a* and Water Clarity (Secchi depth for lakes; turbidity for streams and rivers) (& Level III Ecoregional criteria)		
Pathogen and Pathogen Indicators	—		See EPA's 2012 Recreational Water Quality Criteria		2012
Pentachlorobenzene	608935	NP	1.4 E	1.5 E	2002
Pentachlorophenol	87865	P	0.27 B, C	3.0 B, C, H	2002
pH	—	NP	5 – 9		1986
Phenol	108952	P	10,000 ll, U	860,000 ll, U	2009
Polychlorinated Biphenyls (PCBs)		P	0.000064 B, C, N	0.000064 B, C, N	2002
Pyrene	129000	P	830 B	4,000 B	2002
Selenium	7782492	P	170 Z	4200	2002
Solids Dissolved and Salinity	—	NP	250,000 A		1986
Tetrachlorobenzene,1,2,4,5-	95943	NP	0.97 B	1.1 B	2002
Tetrachloroethylene	127184	P	0.69 C	3.3 C	2002
Thallium	7440280	P	0.24	0.47	2003
Toluene	108883	P	1,300 Z	15,000	2003
Toxaphene	8001352	P	0.00028 B, C	0.00028 B, C	2002
Trichloroethylene	79016	P	2.5 C	30 C	2002
Trichlorophenol,2,4,5-	95954	NP	1,800 B	3,600 B	2002
Vinyl Chloride	75014	P	0.025 C, kk	2.4 C, kk	2003
Zinc	7440666	P	7,400 U	26,000 U	2002
1,1,1-Trichloroethane	71556	P	Z		
1,1,2,2-Tetrachloroethane	79345	P	0.17 B, C	4.0 B, C	2002
1,1,2-Trichloroethane	79005	P	0.59 B, C	16 B, C	2002
1,1-Dichloroethylene	75354	P	330	7,100	2003
1,2,4-Trichlorobenzene	120821	P	35	70	2003
1,2-Dichlorobenzene	95501	P	420	1,300	2003
1,2-Dichloroethane	107062	P	0.38 B, C	37 B, C	2002
1,2-Dichloropropane	78875	P	0.50 B, C	15 B, C	2002
1,2-Diphenylhydrazine	122667	P	0.036 B, C	0.20 B, C	2002
1,2-Trans-Dichloroethylene	156605	P	140 Z	10,000	2003
1,3-Dichlorobenzene	541731	P	320	960	2002
1,3-Dichloropropene	542756	P	0.34 C	21 C	2003
1,4-Dichlorobenzene	106467	P	63	190	2003
2,3,7,8-TCDD (Dioxin)	1746016	P	5.0E-9 C	5.1E-9 C	2002
2,4,6-Trichlorophenol	88062	P	1.4 B, C	2.4 B, C, U	2002
2,4-Dichlorophenol	120832	P	77 B, U	290 B, U	2002
2,4-Dimethylphenol	105679	P	380 B	850 B, U	2002
2,4-Dinitrophenol	51285	P	69 B	5,300 B	2002
2,4-Dinitrotoluene	121142	P	0.11 C	3.4 C	2002
2-Chloronaphthalene	91587	P	1,000 B	1,600 B	2002
2-Chlorophenol	95578	P	81 B, U	150 B, U	2002
2-Methyl-4,6-Dinitrophenol	534521	P	13	280	2002
3,3'-Dichlorobenzidine	91941	P	0.021 B, C	0.028 B, C	2002
3-Methyl-4-Chlorophenol	59507	P	U	U	

4,4'-DDD	72548	P	0.00031 B, C	0.00031 B, C	2002
4,4'-DDE	72559	P	0.00022 B, C	0.00022 B, C	2002
4,4'-DDT	50293	P	0.00022 B, C	0.00022 B, C	2002

*P/NP – Indicates either a Priority Pollutant (P) or a Non Priority Pollutant (NP).

Footnotes

A This human health criterion is the same as originally published in the Red Book which predates the 1980 methodology and did not utilize the fish ingestion BCF approach. This same criterion value is now published in the Gold Book.

B This criterion has been revised to reflect The Environmental Protection Agency's q1* or RfD, as contained in the Integrated Risk Information System (IRIS) as of May 17, 2002. The fish tissue bioconcentration factor (BCF) from the 1980 Ambient Water Quality Criteria document used to derive the original criterion was retained in each case.

C This criterion is based on carcinogenicity of 10^{-6} risk. Alternate risk levels may be obtained by moving the decimal point (e.g., for a risk level of 10^{-5}, move the decimal point in the recommended criterion one place to the right).

D According to the procedures described in the *Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses*, except possibly where a very sensitive species is important at a site, freshwater aquatic life should be protected if both conditions specified in Appendix C to the Preamble-Calculation of Freshwater Ammonia Criterion are satisfied.

F The derivation of this value is presented in the Red Book (EPA 440/9-76-023, July, 1976).

H No criterion for protection of human health from consumption of aquatic organisms excluding water was presented in the 1980 criteria document or in the *1986 Quality Criteria for Water*. Nevertheless, sufficient information was presented in the 1980 document to allow the calculation of a criterion, even though the results of such a calculation were not shown in the document.

I This criterion for asbestos is the Maximum Contaminant Level (MCL) developed under the Safe Drinking Water Act (SDWA).

J This fish tissue residue criterion for methylmercury is based on a total fish consumption rate of 0.0175 kg/day.

M EPA is currently reassessing the criteria for arsenic.

N This criterion applies to total pcbs, (e.g., the sum of all congener or all isomer or homolog or Aroclor analyses.)

O This criterion for manganese is not based on toxic effects, but rather is intended to minimize objectionable qualities such as laundry stains and objectionable tastes in beverages.

P Although a new RfD is available in IRIS, the surface water criteria will not be revised until the National Primary Drinking Water Regulations: Stage 2 Disinfectants and Disinfection Byproducts Rule (Stage 2 DBPR) is completed, since public comment on the relative source contribution (RSC) for chloroform is anticipated.

R U.S. EPA. 1973. Water Quality Criteria 1972. EPA-R3-73-033. National Technical Information Service, Springfield, VA.; U.S. EPA. 1977. Temperature Criteria for Freshwater Fish: Protocol and Procedures. EPA 600/3-77-061. National Technical Information Service, Springfield, VA.

S This recommended water quality criterion for arsenic refers to the inorganic form only.

T U.S. EPA. 1986. Ambient Water Quality Criteria for Dissolved Oxygen. EPA 440/5-86-003. National Technical Information Service, Springfield, VA.

U The organoleptic effect criterion is more stringent than the value for priority toxic pollutants.

Z A more stringent Maximum Contaminant Level (MCL) has been issued by EPA under the Safe Drinking Water Act. Refer to drinking water regulations 40CFR141 or Safe Drinking Water Hotline (1-800-426-4791) for values.

jj This recommended water quality criterion is expressed as total cyanide, even though the IRIS RFD we used to derive the criterion is based on free cyanide. The multiple forms of cyanide that are present in ambient water have significant differences in toxicity due to their differing abilities to liberate the CN-moiety. Some complex cyanides require even more extreme conditions than refluxing with sulfuric acid to liberate the CN-moiety. Thus, these complex cyanides are expected to have little or no 'bioavailability' to humans. If a substantial fraction of the cyanide present in a water body is present in a complexed form (e.g., $Fe_4[Fe(CN)_6]_3$), this criterion may be over conservative.

kk This recommended water quality criterion was derived using the cancer slope factor of 1.4 (LMS exposure from birth).

ll This criterion has been revised to reflect the Environmental Protection Agency's cancer slope factor (CSF) or reference dose (RfD), as contained in the Integrated Risk Information System (IRIS) as of (date of publication of Final FR Notice). The fish tissue bioconcentration factor (BCF) from the 1980 Ambient Water Quality Criteria document was retained in each case.

Organoleptic Effects (e.g., taste and odor)

Pollutant	CAS Number	Organoleptic Effect Criteria (µg/L)	FR Cite/ Source
Acenaphthene	83329	20	Gold Book

Color		NP	Gold Book
Iron	7439896	300	Gold Book Red Book
Monochlorobenzene	108907	20	Gold Book
Tainting Substance		NP	Gold Book
3-Chlorophenol	—	0.1	Gold Book
4-Chlorophenol	106489	0.1	Gold Book
2,3-Dichlorophenol	—	0.04	Gold Book
2,5-Dichlorophenol	—	0.5	Gold Book
2,6-Dichlorophenol	—	0.2	Gold Book
3,4-Dichlorophenol	—	0.3	Gold Book
2,4,5-Trichlorophenol	95954	1	Gold Book
2,4,6-Trichlorophenol	88062	2	Gold Book
2,3,4,6-Tetrachlorophenol	—	1	Gold Book
2-Methyl-4-Chlorophenol	—	1800	Gold Book
3-Methyl-4-Chlorophenol	59507	3000	Gold Book
3-Methyl-6-Chlorophenol	—	20	Gold Book
2-Chlorophenol	95578	0.1	Gold Book
Copper	7440508	1000	Gold Book
2,4-Dichlorophenol	120832	0.3	Gold Book
2,4-Dimethylphenol	105679	400	Gold Book
Hexachlorocyclopentadiene	77474	1	Gold Book
Manganese	7439965		
Nitrobenzene	98953	30	Gold Book
Pentachlorophenol	87865	30	Gold Book
Phenol	108952	300	Gold Book
Zinc	7440666	5000	45 FR79341

Notes:

1. These criteria are based on organoleptic (taste and odor) effects. Because of variations in chemical nomenclature systems, this listing of pollutants does not duplicate the listing in Appendix A of 40 CFR Part 423. Also listed are the Chemical Abstracts Service (CAS) registry numbers, which provide a unique identification for each chemical.

Additional Notes

1. **Criteria Maximum Concentration and Criterion Continuous Concentration**

   The Criteria Maximum Concentration (CMC) is an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed briefly without resulting in an unacceptable effect. The Criterion Continuous Concentration (CCC) is an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed indefinitely without resulting in an unacceptable effect. The CMC and CCC are just two of the six parts of an aquatic life criterion; the other four parts are the acute averaging period, chronic averaging period, acute frequency of allowed exceedence, and chronic frequency of allowed exceedence. Because 304(a) aquatic life criteria are national guidance, they are intended to be protective of the vast majority of the aquatic communities in the United States.

2. **Criteria Recommendations for Priority Pollutants, Non Priority Pollutants and Organoleptic Effects**

   This compilation lists all priority toxic pollutants and some non priority toxic pollutants, and both human health effect and organoleptic effect criteria issued pursuant to CWA §304(a). Blank spaces indicate that EPA has no CWA §304(a) criteria recommendations. For a number of non-priority toxic pollutants not listed, CWA §304(a) "water + organism" human health criteria are not available, but EPA has published MCLs under the SDWA that may be used in establishing water quality standards to protect water supply designated uses. Because of variations in chemical nomenclature systems, this listing of toxic pollutants does not duplicate the listing in Appendix A of 40 CFR Part 423. Also listed are the Chemical Abstracts Service CAS registry numbers, which provide a unique identification for each chemical.

3. **Human Health Risk**

   The human health criteria for the priority and non priority pollutants are based on carcinogenicity of 10^{-6} risk. Alternate risk levels may be obtained by moving the decimal point (e.g., for a risk level of 10^{-5}, move the decimal point in the recommended criterion one place to the right).

4. **Water Quality Criteria published pursuant to Section 304(a) or Section 303(c) of the CWA**

Many of the values in the compilation were published in the California Toxics Rule. Although such values were published pursuant to Section 303(c) of the CWA, they represent the Agency's most recent calculation of water quality criteria and are thus the Agency's 304(a) criteria.

5. **Calculation of Dissolved Metals Criteria**

The 304(a) criteria for metals, shown as dissolved metals, are calculated in one of two ways. For freshwater metals criteria that are hardness-dependent, the dissolved metal criteria were calculated using a hardness of 100 mg/l as CaCO3 for illustrative purposes only. Saltwater and freshwater metals' criteria that are not hardness-dependent are calculated by multiplying the total recoverable criteria before rounding by the appropriate conversion factors. The final dissolved metals' criteria in the table are rounded to two significant figures. Information regarding the calculation of hardness dependent conversion factors are included in the footnotes.

6. **Maximum Contaminant Levels**

The compilation includes footnotes for pollutants with Maximum Contaminant Levels (MCLs) more stringent than the recommended water quality criteria in the compilation. MCLs for these pollutants are not included in the compilation, but can be found in the appropriate drinking water regulations (40 CFR 141.11-16 and 141.60-63), or can be accessed through the Safe Drinking Water Hotline (800-426-4791) or online.

7. **Organoleptic Effects**

The compilation contains 304(a) criteria for pollutants with toxicity-based criteria as well as non-toxicity based criteria. The basis for the non-toxicity based criteria are organoleptic effects (e.g., taste and odor) which would make water and edible aquatic life unpalatable but not toxic to humans. The table includes criteria for organoleptic effects for 23 pollutants. Pollutants with organoleptic effect criteria more stringent than the criteria based on toxicity (e.g., included in both the priority and non-priority pollutant tables) are footnoted as such.

8. **Gold Book**

The "Gold Book" is Quality Criteria for Water: 1986. EPA 440/5-86-001.

9. **Correction of Chemical Abstract Services Number**

The Chemical Abstract Services number (CAS) for Bis(2-Chlorisoprpyl) Ether, has been revised in IRIS and in the table. The correct CAS number for this chemical is 108-60-1. The previous CAS number for this pollutant was 39638-32-9.

10. **Contaminants with Blanks**

EPA has not calculated criteria for contaminants with blanks. However, permit authorities should address these contaminants in NPDES permit actions using the States' existing narrative criteria for toxics.

11. **Specific Chemical Calculations**

Selenium—Aquatic Life
This compilation contains aquatic life criteria for selenium that are the same as those published in the proposed CTR. In the CTR, EPA proposed an acute criterion for selenium based on the criterion proposed for selenium in the Water Quality Guidance for the Great Lakes System (61 FR 58444). The GLI and CTR proposals take into account data showing that selenium's two prevalent oxidation states in water, selenite and selenate, present differing potentials for aquatic toxicity, as well as new data indicating that various forms of selenium are additive. The new approach produces a different selenium acute criterion concentration, or CMC, depending upon the relative proportions of selenite, selenate, and other forms of selenium that are present.
EPA is currently undertaking a reassessment of selenium, and expects the 304(a) criteria for selenium will be revised based on the final reassessment (63 FR 26186). However, until such time as revised water quality criteria for selenium are published by the Agency, the recommended water quality criteria in this compilation are EPA's current 304(a) criteria.

Appendix A—Conversion Factors for Dissolved Metals

Metal	Conversion Factor			
	freshwater CMC	freshwater CCC	saltwater CMC	saltwater CCC[1]
Arsenic	1.000	1.000	1.000	1.000
Cadmium	1.136672-[(ln hardness)(0.041838)]	1.101672-[(ln hardness)(0.041838)]	0.994	0.994
Chromium III	0.316	0.860	—	—
Chromium VI	0.982	0.962	0.993	0.993
Copper	0.960	0.960	0.83	0.83
Lead	1.46203-[(ln hardness)(0.145712)]	1.46203-[(ln hardness)(0.145712)]	0.951	0.951
Mercury	0.85	0.85	0.85	0.85
Nickel	0.998	0.997	0.990	0.990
Selenium	—	—	0.998	0.998

Metal	Conversion Factor			
	freshwater CMC	freshwater CCC	saltwater CMC	saltwater CCC[1]
Silver	0.85	—	0.85	—
Zinc	0.978	0.986	0.946	0.946

Appendix B—Parameters for Calculating Freshwater Dissolved Metals Criteria That Are Hardness-Dependent

Chemical	m_A	b_A	m_C	b_C	Freshwater Conversion Factors (CF)	
					CMC	CCC
Cadmium	1.0166	-3.924	0.7409	-4.719	1.136672-[(*ln*hardness)(0.041838)]	1.101672-[(*ln*hardness)(0.041838)]
Chromium III	0.8190	3.7256	0.8190	0.6848	0.316	0.860
Copper	0.9422	-1.700	0.8545	-1.702	0.960	0.960
Lead	1.273	-1.460	1.273	-4.705	1.46203-[(*ln*hardness)(0.145712)]	1.46203-[(*ln*hardness)(0.145712)]
Nickel	0.8460	2.255	0.8460	0.0584	0.998	0.997
Silver	1.72	-6.59	—	—	0.85	—
Zinc	0.8473	0.884	0.8473	0.884	0.978	0.986

Hardness-dependant metals' criteria may be calculated from the following:

CMC (dissolved) = $\exp\{m_A\,[\ln(\text{hardness})] + b_A\}$ (CF)

CCC (dissolved) = $\exp\{m_C\,[\ln(\text{hardness})] + b_C\}$ (CF)

The Gold Book

Quality Criteria for Water, 1986 (PDF) (477 pp., 4.6 MB) May 1986

The Red Book

Quality Criteria for Water, 1976 (PDF) (534 pp., 6.2 MB) July 1976

Chemical Specific Criteria Documents from the 1980s

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